XII. *Observations completing an outline of the Life History of* Lycaena arion, *L.* By T. A. Chapman, M.D., F.Z.S.

[Read October 6th, 1915.]

Plates XLVII–XLIX.

On June 2nd, 1915, I laid before the Society an account of a small but important discovery as to the habit and food of the larva of *Lycaena arion*, L., as it was attaining its full growth in the spring. This showed that at this stage it lived in or near the nest of *Myrmica scabrinodis*, Nyl., and fed on the larvae of that ant, and pointed to the larva not clearing the *primae viae* in the usual lepidopterous manner.

I was of course very desirous of learning something of the autumn habits of the larva, from the point at which all previous efforts to trace its proceedings had, in spite of prolonged investigation by many observers, quite failed. With the light thrown on the matter by my spring results, this seemed more hopeful, since there was now for guidance the fact that the larva associated with ants and preyed on their larvae, and whatever number of species of ant it might thus parasitise, it was at least certain that *Myrmica scabrinodis* was one of them.

By the kindness of our President and Mr. Frohawk, I obtained some eggs of *L. arion* in July, and in August had reared some larvae to the critical stage. I am also much indebted to Mr. Donisthorpe for advice and assistance in regard to ants, and especially for two observation nests of *Myrmica scabrinodis*, one of the type and one of the var. *sabuleti*.

Among other observations I made some very imperfect ones in regard to *Donisthorpea flava*, De Geer. I have not, either now or in previous years, met with any real evidence of any sort to show that the larva of *L. arion* can live in the nest of *D. flava*. Nor, on the contrary, is it surprising, especially since any accurate knowledge is so recent, in view of the difficulty of proving a negative, that there is no proof that it cannot live with *D. flava*. But it remains as a weighty circumstance that all the exertions that have

been made, and to which I have contributed my share, to find the larva with *D. flava* have met with no scintilla of success, pointing very strongly to the larva never in fact associating with that ant. The hills of *D. flava* are very often covered with thyme, on which, as on other plants of thyme, the ♀♀ of *L. arion* impartially lay their eggs. This, no doubt, is why *D. flava* has always been supposed to be the ant, if there was an ant, affected by *L. arion*. It is, of course, the fact that nests of *M. scabrinodis* are common, often as abundant as those of *D. flava*, but much less conspicuous, and in more than one instance I can confirm the remark of Frederick Smith, who says in regard to *Donisthorpea* (*Formica*) *flava* (Brit. Mus. Cat. Fossorial *Hymenoptera, Formicidae*, and *Vespidae*, p. 16, 1858): "This species is sometimes found occupying one side of a hillock, whilst *Myrmica scabrinodis* appropriates the other."

I append the notes of Mr. Donisthorpe's observations and my own; it may be useful before giving them to shortly state what they demonstrate.

When the *arion* larva leaves the thyme and sets out on its travels there is a vague indication that if it comes across the trail of *M. scabrinodis*, that is, one of its beaten tracks, it accepts it as a road to be taken. At length it meets or is found by an ant of this species (or some other). It may be, however, that this first and other ants pay little attention to it; at length, however, one does. The ant examines it and proceeds much as ants do when milking Lycaenid larvae; it goes further than this, it leaves it and circles round it, returns, again milks the larva, and may do this several times. At length, by some agreement, apparently on some signal given by the ant, the larva assumes a most extraordinary form, swelling up the thoracic segments at the expense of the others; such a form as I have seen no other larva assume. The ant then seizes it behind the thorax and carries it into her nest. Here the larva associates with the ants, but receives little or no notice from them, is always at a place where the ants thickly surround a mass of brood, and on this brood the *L. arion* feeds and grows rapidly to a length of 8 to 10 mm. —so rapidly, that it would be full-grown before November, if it went on; as it is not full-grown in April, it follows that it takes a winter rest about half-grown.

My notes with remarks they suggest are as follows, but I place first Mr. Donisthorpe's.

The record, of the two larvae of *L. arion* placed in an observation nest of *M. scabrinodis* of Mr. Donisthorpe's, on August 4th, and of two others, given by him at intervals, as follows :—

" August 9th.—The larva we put into the nest got out in the night, but I put it back and blocked it in with sand, as also the other. The latter was dragged in by an ant, but not hurt, and many ants gathered round it. To-day I can see only one larva, but it is in the midst of the ants and their brood, and is *distinctly* larger. There are ants' eggs and young larvae in the nest, I find, besides older larvae and pupae.

" August 11th.—The one larva is still in the large chamber, and is usually covered with the ants and their brood; when I move the cover, and all the ants run into other galleries and parts of the nest, it becomes exposed and moves slowly; it is again larger to-day. I cannot see the other *arion* larva anywhere, but there are many places to hide in in the earth nest."

On August 13th Mr. Donisthorpe received two more larva, perhaps not so fresh as might be desirable; he notes that he introduced one larva into a *scabrinodis* nest, not much attention was paid to it. It crawled about in the light-chamber and climbed up the side; still on the wall at one o'clock.

Another nest of *scabrinodis* on same date had the other larva introduced into light-chamber. Great attention paid by one ☿ (larva swells in front, as described by Dr. Chapman). One o'clock, larva still attended by the one ☿ in same place.

August 16th he says : " To-day both are dead, the one looks as if the ants had killed it and sucked the body dry; all went well at first, and they lived in the colonies for two days."

Later he sent me the dead larvae, saying : " The one I think died, it never went out of the first (light, dry) chamber; very little attention was paid to it. The other I believe was killed and sucked dry, at least it looks like it. It was taken a great deal of notice of; yesterday it was dead in the last (dark, damp) chamber."

Mr. Donisthorpe sent me these dead larvae.

The appearance of the larvae, dried up as they were, certainly bore out Mr. Donisthorpe's conclusions; but on soaking and macerating them, they both appeared to have

the skin equally intact. The probable cause of the difference of appearance is that the larvae both died from exhaustion, from not reaching the ants' nests (and brood) soon enough; the one that died outside the nest, *i. e.* in (light, dry) chamber, which the ants treat as not in the nest, looking there for food and depositing their debris, was never meddled with by the ants; the other, rather less exhausted, did reach the nest, but too late, and, dying in the nest, was examined and moved about by the ants, and being limp and inelastic, preserved the impressions of their jaws, without having been injured by them. The point is interesting, as bearing on the question as to whether the *M. scabrinodis* may be inimical to the larvae of *arion* in any particular circumstances.

"August 16th.—The old one in the earth nest is well and larger and in usual spot.

"August 18th.—Larva still larger, in other side of big chamber.

"August 19th.—Yesterday the larva was in the large chamber in the earth nest, and was considerably larger. I measured it by putting my micro. mm. slide on the glass above it, and it was a little over 5 mm., and broad in proportion. To-day I can't see or find it; it is not in the box outside the nest, as I have searched every corner and swept up every grain of sand or remains of insects cast out by the ants and examined it with a lens.

"What can have become of it? Can it have burrowed into the earth? I take it, the ants would not have destroyed it after it had been in the nest for fourteen days.

"August 31st.—I have not seen my larva since; I look every day. I believe its food in great part was the droppings and pellets of the ants. I never saw it feeding on the brood, but it was often apparently eating on the floor of the nest. This is (as I proved, *see* Ent. Rec., vol. 24, p. 35–6, 1912) the food of the larva of the fly *Microdon mutabilis*.

"September 14th.—I have not seen my larva again, nor have I found its body or parts of it."

These observations of Mr. Donisthorpe's suggest one or two points worth discussion. The most important is as to the surmise that the larva hides for the winter in loose earth in or near the nest. As my plaster nests were devoid of earth, they afforded no facts bearing on such a point, but my most successful larva was much larger and older

than Mr. Donisthorpe's when it died, so that the theory looks very doubtful, but cannot be simply dismissed. If the theory be correct, this larva may again appear.

The other point is as to the food. Since my larvae eat the larvae of the ants, it seems unlikely that they would eat the droppings and pellets of the ants. Nothing in the behaviour of my specimens gave any confirmation to such an idea. I think it probable that Mr. Donisthorpe, who is, perhaps, not very familiar with the ways of Lycaenid larvae, was deceived by the slow to and fro lateral movements of the front and head of the larva, as it marches with dignified deliberation. The movement means probably making a silken ladder, and also perhaps is exploratory; at any rate, it is not very different to the movements of a slug or snail when eating growths on the surface of a tree or paling. In the case of the Lycaenid larva, however, it has nothing to do with actual feeding.

My own notes and observations follow.

August 2nd.—Placed a larva on nest of *D. flava*; it shortly found an opening and disappeared downwards.

August 3rd.—Another larva to-day did precisely the same as the one yesterday.

August 4th.—Took two larvae to Mr. Donisthorpe, which were placed in an observation nest of *M. scabrinodis* (*see* Mr. Donisthorpe's notes above), and brought home a nest each of *M. scabrinodis* and *M. s.* var. *sabuleti*, in plaster nests.

August 5th.—Placed a larva in each of the nests noted yesterday; the ants paid a little vague attention to them, but seemed neither pleased nor displeased with them, nor were they seen to get any "honey."

August 8th.—Failed to see a larva in either nest, and one at least was very completely scrutinised.

August 10th.—Mr. Donisthorpe reports one of the larvae in his nest to be quite at home amongst the brood, and to be "*distinctly* larger."

Amongst the debris from the nests found remains of an *arion* larva, shrivelled but not apparently injured.

August 12th.—Placed two larvae of *arion* in the plaster nest of *M. scabrinodis* var. *sabuleti*, one in what may be called the approach to the nest, the other in a central position at the moment unoccupied. The one in the approach, after a pause, began to travel slowly, and by what one can hardly suppose to be other than accident

went directly towards the opening to the next (more central) compartment, though it is, of course, possible the route followed by the ants had left some impression of the correct road. It finally got into the next compartment and advanced some 20 mm. therein. This journey did not take very long, and in the course of it various ants walked past it and over it, paying it no attention. At length one ant seemed interested, examined it, went round it and examined it with its antennae with care, the process occupying several minutes; at length it addressed itself to the honey-gland region in the orthodox way, standing behind and tapping the sides of the larva with its antennae, then passing its mouth over the last segments of the larva nearly everywhere, as if expecting something not very clear to it, and finally seemed to steady at the honey-gland, which it had previously passed over unavailingly, but which now obviously afforded something. On a further dealing with the larva, the latter bunched itself up in an attitude I had not previously seen; the ant then let it alone, but returning, the ant antennaed the larva variously, and the latter again bunched itself up—the head much retracted underneath, the thoracic segments swollen up, and the segments behind very attenuated, giving the larva a decided approach to the well-known outline of a Buprestid larva. I had never seen any approach to this form before, either in this or any other Lycaenid larva. In a few seconds, whilst I was marvelling over the matter, the ant passed its jaws over it in various directions, and seemed quickly to find the right place, picked it up by somewhere about the second abdominal segment, directly over the dorsum, and, the larva remaining in its curious attitude, carried it, as it would an ant larva or pupa, right away to the inhabited portion of the nest. The other larva wandered about a little, like the other unnoticed by the ants; but whilst I have been writing this note it has disappeared, and as the distance to cover was more than it could cover in the interval, it must have been carried off like the first one.

Later I placed a larva in a plaster nest of *M. scabrinodis*; after some minutes of neglect, the larva was in the outer chamber, an ant became much interested, and milked the larva over and over again. The process was curious: the larva would be walking along and the ant examining it, then the ant specially attended to the honey region, and, stationed usually behind the larva, it tapped it towards

either side with its antennae and advanced its head over the gland; the larva would then stop walking, retreat its head under the metathorax, and open rather widely the 6th to 7th abdominal incision, to a breadth dorsally of nearly half a segment width, diminishing to either side, an area conspicuous by being devoid of hairs or stellate hair-bases. For some seconds the larva and ant would be apparently motionless, the ant no doubt receiving honey. On the first approach to this position a definite drop of fluid was visible over the honey-gland just as the ant approached it, when it at once disappeared. After some seconds the ant left the larva, and seemed to have a deal of cleaning of its legs and antennae to do; the larva at once protruded its head and began to walk. Shortly the ant took several walks round the larva, then approached and went through the same process, and this was repeated half a dozen times, except on the first occasion no drop of fluid was seen, but after each occasion the ant did much cleaning, though there seemed no possibility of the honey or anything else having messed it. Then the carrying process was begun, in what precise way the ant instructed the larva was not clear, but it assumed the bunched attitude; this consists, as was more clearly seen on this occasion, in the larva swelling up the meso- and meta-thorax, and so depressing the prothorax forwards as to make the prothoracic plate face almost ventrally, instead of dorsally. The incisions, meso-metathoracic and metathorax—1st abdominal—were in this process widely opened, showing their smooth areas, and the remaining abdominal segments shrunk. This particular ant did not seem to quite understand its business; after several attempts it seized the larva by the meso-meta incision and carried the larva half an inch, but the process seemed uncomfortable, at least to the larva, which did not fully retain the bunched attitude, and the ant let it drop. The ant after an interval again milked the larva, and again got the larva to bunch, but failed to get hold of it properly, and finally walked off. A quarter of an hour later the larva was still walking about, but after a further twenty minutes had disappeared and was detected in the thick of the nest amongst ants and larvae. This nest has young larvae, but not any eggs to be seen.

August 14th.—One of the larvae in the *sabuleti* nest is obviously larger than it was, or than any larva just quit-

ting the thyme. The larvae in both nests walk about in their leisurely way, when the ants are induced to leave the crowded spots where they happen to be; but usually when the nest is first looked at on removing the screen they are not easily seen, and are hidden amongst the crowded patches of ants and brood; the ants seem to take no more notice of them than they do of each other.

August 15th.—The largest larva appears to be still larger, certainly more than twice the bulk of its first dimensions, and quite 1 mm. longer.

August 15th.—The largest larva with *M. scabrinodis* var. *sabuleti* measures 5·0 mm.; having come up to the glass he was easily measured; he was equally increased in height and width, and looked decidedly paler than when small.

In regard to the carrying in of the larva to the nest by the ant, the question arises as to whether the ant or the larva gives the actual signal for the portage. My own impression is that the initiative lies with the ant. In the preliminary process of milking, if the ant walks over the larva, it slows, but hardly stops walking, but as soon as the ant taps with its antennae for milk, and afterwards whilst the mouth of the ant is applied to the gland, the larva rests quite quiet, with its head retracted; the moment the ant withdraws, the larva extrudes its head and begins walking. As the time for portage arrives, the ant taps the larva more forwards, but not, so far as I noticed, very differently to what it had done before, and then the larva takes the attitude for being carried. In one case, the ant, from the attitude of sucking the honey, made a little gallop forwards several times, and it was after one of these that the attitude for being carried was assumed. On another occasion, when the ant made no very special forward movement, the larva assumed the special attitude, to which the ant paid no attention; it seemed probable that the ant had inadvertently done something that the larva took to be the expected signal, but the ant had clearly not reached that stage in the negotiations. Were it the larva that gave the signal, then the ant ought to have responded whether quite ready or not.

August 17th.—After frequently watching the larvae in the nest; all of them have grown more or less, the largest is over 5 and probably nearly 6 mm. long; the impression is received that the ants pay no attention whatever to the larvae; when they meet them they walk over them, never

appear to hold any communication with them, as they frequently do with each other when they meet. If the amount of watching has been sufficient, it would follow that the ants do not feed the larvae, but that the latter forage for themselves; there is nothing for them to find for themselves but the eggs and larvae of the ants, and considering that when older they eat the larvae, it seems tolerably certain that at this stage they feed on the young brood of the ants.

August 19th.—The largest larva is now 6 mm. long, stout in proportion, and of a fine translucent flesh-colour. I succeeded in establishing an observation nest of *D. flava* some days ago, but of a very amateurish structure; still it *is* an observation nest. I placed in it two larvae of *L. arion*, but they were, I feared, not sufficiently fresh. I have not since been able to discover any trace of them alive or dead. I hardly think either of them can possibly be there, but if this be so, I feel unable to decide whether the larvae were past a condition to succeed anywhere, or whether the *flava* were inhospitable. The pacific nature of *D. flava* in one respect struck me: they readily accepted queens picked up superficially on another nest, and supposed to be new queens of the season as yet unprovided for; but further, ants from another nest added to them were fraternised with, with hardly a question asked.

August 25th.—Larvae have been growing. At present there is in var. *sabuleti* nest a large larva 6·5 mm. long, and a smaller nearly 5·0 mm., and in the *scabrinodis* nest one nearly 6·0 mm. long; they are fond of resting on the sides of the compartments away from the ants. The ants run over them without paying them any attention, and I have not seen one milked.

August 26th.—The larvae do not look so well, especially the one in *scabrinodis* looks dirty and hardly so large. The others are a little dirty, seem less inclined to mix with the ants, *i. e.* are more often seen separate from the ants, by themselves, in the middle of a compartment or on a slope.

August 28th.—The *scabrinodis* larva looks bad, decidedly shrunken, little over 4·0 mm. long. The others much as at last note.

August 29th.—The *scabrinodis* larva is found dead, rather dried and nearly divided into two. The *sabuleti* ones don't somehow look flourishing, but are of about the same size as

noted on 25th. The smaller one is indeed rather larger, about 6·0 mm. long, it has some dark material over last segment or two, almost suggesting it had been bitten by ants and exudation had dried; the larger one has retreated into a small recess (opening prepared for communication with exterior) and has not moved since yesterday, whether ants are with it or not; it has a certain amount of dark incrustation (of dirt?).

29th.—Afternoon. The smaller larva is amongst the ants and moving about amongst them, apparently quite at home.

The present conditions suggest that at the stage the larvae have now reached they may have a habit of hiding amongst the looser materials in or over the nest, not, of course, afforded in these plaster nests, and feed less frequently (not at all till spring?), and do not associate so freely with the ants. At the recent rate of growth they would be full-fed in a few weeks more, yet probably naturally there is not from about this season onwards any excess of brood on which they could feed.

August 30th.—The dead *scabrinodis* larva, after a little soaking, expanded to nearly 8 mm., and looked very like it did when last seen looking well in the nest. It proved to have been cut into, but none of the interior had been eaten; the shrinking may have been due to desiccation or to the ants sucking the fluids; the honey-gland region looked healthy and uninjured, but over much of the larva were little hard black patches and spots that seemed to be the same as a (fungus?) disease that attacks larvae, and has frequently done so in larvae I have reared; the larvae when dead are often found to be very hard and solid throughout.

The largest *sabuleti* larva is found dead this morning in the nest, close by the recess in which it was noted yesterday as sheltering. It measured just over 7·0 mm., but looked a little shrunken, and its living length was probably 8 to 9 mm. It was apparently wounded (*post-mortem*?) in the honey-gland region. The cause of death appeared to be the black mark disease, of which spots were on most segments, but largely affected the 2nd thoracic and 1st and 2nd abdominal, the two latter being affected over nearly the whole dorsum.

The gut extracted from this specimen showed some accumulated material near the posterior end. It presented

no recognisable or organised material, unless one so accept some globules apparently of fat.

The remaining (*sabuleti*) larva, originally the smaller, is amongst the ants and brood and looks healthy, unless a blackness of the segments behind the honey-gland (possibly dirt) mean black-spot disease. It is about 9·0 mm. long, possibly 10·0; it does not happen to pose well for accurate measurement. Happening a little later to find the larva in a more convenient position, find it measures rather over 9·0 mm.

September 2nd.—Observed that the larva in *sabuleti* nest (the only one remaining) appeared to have voided some "frass." It was black, small in size, but of the ordinary form of lepidopterous "frass." It was rather soft. When put on a slide, pressed down and examined by microscope, it was seen to contain hairs, bits of cuticle and other portions of ant larvae or pupae, apparently by no means small ones. The larva was measured with approximate accuracy as 7·8 mm. long, 2·8 high, 3·0 wide; it looks clean and healthy except the "dirt" (or whatever it is) on the dorsum of 9th and 10th segments.

Amongst the ant material of the "frass" were also seen two jaws of ant larvae.

September 6th.—Examined two (one noted under dates August 2nd and 4th) nests (artificial) of *D. flava* into which larvae of *arion* had been introduced, and found no trace of them; this, however, goes for little, as both nests were defective—one without any brood and the other hardly established when the larvae were introduced. The observation only amounts to a failure to show that *arion* can reside with *D. flava*, and in no way shows that it cannot.

September 8th.—Happened to notice, as I had done on previous occasions, that the *M. sabuleti* placed the debris of their nest on a slip of glass used as a tray on which to provide them with sugar; it occurred to me, as it ought to have done before, that this debris might contain faeces of the *L. arion* larva. On examining the debris found that there were some items very like the faeces already reported on, viz. small dark-coloured objects about 0·6 mm. long, at first glance cylindrical, but on closer observation seen to consist of two nearly spherical masses closely pressed together. (The original deposit had this duplex character.) One of these placed on a slide and examined under a low power was seen to consist largely of hairs of the ant larvae,

and a second specimen was identical. The double pellets easily resolved themselves into two single ones when handled, and about two dozen of these single pellets were retrieved.

The glass had been put into the nest clean on September 6th.

A specimen contained jaws of ant larvae.

September 9th.—The ant midden was found this morning to contain nine of the rounded pellets of *arion's* dejecta; they contained several jaws, etc.; in one case the two jaws were still connected together by portions of the head. In all the examples mounted the hairs are often, perhaps usually, connected, a few together, by portions of the larval skin of the ant, as was not the case with the specimens from the spring (wild) larva.

I have never succeeded in seeing the larva eating, but the form of the rooms of the nest, with the Lycaenid habit of carrying the head withdrawn under the prothorax, make such an observation difficult, if indeed possible. The larva very usually has a position, with the head against the little mass of brood, and itself amongst the ants surrounding it. I say *little* mass of brood because there are not a great many larvae and pupae, the nest not being strong and the *arion* largely depleting them, of course. At other times the *arion* larva is, say, anywhere, owing probably to the ants not unfrequently changing the position of the brood nest, in accordance, I imagine, with the failure of my efforts to maintain for them a uniform dampness, and with my so frequently disturbing them for observation.

September 13th.—The larva has not been so well for a few days, has more lines of dirt (?) on it, and to-day only one small (supposed) faecal deposit is found.

September 14th.—Larva lies this morning on its side, dead, very little shrunk, no cause of death obvious except the black lines suggesting fungus disease. No deposits this morning.

After this date nothing at all resembling the *arion* excreta have been found in either nest. It occurred to me that it might be suggested that the ants, perchance, tore up the larval skins when they were cast, on change to pupa, and carried them out mixed with some soft material to the midden, and that the *arion* excreta were really ordinary ant products. Both before and after the death

of the last larva, I examined the midden materials and found therein the cast skins of the ants, shrivelled and a little dirty, but otherwise sound and intact. One of these skins is shown in photograph on Plate XLIX, fig. 2.

The last excretum of *arion* (only one) was found on the day preceding its death. I feel no doubt that these were really the excreta of the butterfly larva. The ants did not feed the larva, and its rapid growth could not possibly be accounted for, if it fed on the ants' droppings, which were, however, always plentiful enough in the midden, as small oval pellets usually black but sometimes pale and less than half the diameter of the *arion* pellets. In the midden section of the nest the plaster was disfigured by many small black spots, apparently excreta of some sort of the ants, but the living portion of the nest was almost free from any such disfigurement. By making errors in keeping the nest properly moist or dry, one forced the ants to change their residence from one cell to another, and at the same time confused them as to which place was properly the midden.

On Plate XLVIII I have placed photographs of portions of slides of the *arion* faeces, which show the very largest portion of ant larval skin I could find; usually the portions are small, so as only to have a few hairs in each, much as shown on Plate XLVII.

Those larvae that died and whose interiors I examined had, practically, no intestinal contents. The larva taken in spring had the intestine rather loaded, which led me to believe that it voided no excreta whilst living with the ants. This is obviously not the case with the larva in autumn, though it continues probable that it is so in spring.

Both my larvae and Mr. Donisthorpe's fed up in four or five weeks to a length of from 7 to 9 mm. If this be compared with the size of the larva in May, the difference is not very great, and the extra growth was probably all made in spring. At any rate from September to May the larva grows comparatively slowly, and probably is quiescent for most of the time. Whatever was the immediate cause of death of my larvae, it seems not unlikely that the true one was that the plaster nests afforded no proper shelter for this purpose. Against this is the fact that my last larva fed fairly freely up to a day or two before its death.

The facts here reported give us in any case a fairly com-

plete view of the life of the larva of *L. arion* in its last instar, which has been such a puzzle and mystery to us all for so many years. They are so remarkable, as in some degree to explain why they have so long resisted our efforts to observe them.

The interview of the larva with the ant (*Myrmica*) is not unlike in its first stages that of an ant with any other larva of a blue that has a honey-gland. But its culmination in the ant carrying the larva into the nest is not only remarkable as a simple fact, but the extraordinary change of form which the larva assumes during the process is astonishing.

I have long been of opinion that the ants collect the larvae of *P. argyrognomon* and *A. coridon* (and no doubt of other species) and carry them to special plants on or close to their own nests; but, so far as I know, no one has seen the actual transfer take place, so that one cannot say that these larvae when so carried do not behave in the remarkable manner observed in *L. arion*.

When the larva is in the ants' nest, it appears to have no protection against the ants of any sort. The ants appear to be entirely neutral towards it, paying no attention whatever to its presence either in a friendly or inimical way.

When the ants were undisturbed, either by exposure to light during observation, or by undue variations of moisture, they were always in little crowds over their brood, and the larva of *arion* almost always had a place amongst these with its head directed towards the brood. That the ants should be so indifferent to its presence whilst it was devouring their brood is difficult to understand, the more so that I never saw any ant obtaining "honey" from it, or apparently examining it with that object. This must, however, be taken *cum grano*, because when the ants (and larva) were under observation the intrusion of light into the nest of course interfered with the natural and usual behaviour both of larva and ants.

I have a natural nest of *Myrmica laevinodis* supplied with four larvae of *L. arion*; whether an examination of this by and bye will add to my knowledge remains to be seen, but I am not very hopeful.

Of further points in the life-history of *L. arion* that have still to be discovered the most interesting and obvious are, perhaps, the question as to what species of ants, beyond

the two or three species of *Myrmica* which we know to welcome it, afford habitats for its larva in their nests, and what are the species which it is unable to quarter itself upon, and, as a second point, whether the larva passes the winter in close association with the ants, or finds a more or less separate apartment in which to spend the period in which it is more or less dormant and does little or no feeding.

Explanation of Plates XLVII–XLIX.

PLATE XLVII.

Two photographs of portions of faeces of *L. arion* larva (Sept. 2, 1915) × 45.

PLATE XLVIII.

Two portions of *arion* faeces. These were selected as showing the largest portions of the skin of the ant larva in one piece; generally they are in small portions, as in Plate XLIX × 45.

PLATE XLIX.

Shows, fig. 1, another portion of *arion* faeces, the bits of ant larva being small × 45; fig. 2, a cast larva skin of the ant, such as were easily found in the debris of the ant midden × 35.